serve as an enclosure for molecules. In some embodiments, the objects constitute vesicles, liposomes, capsules, or other enclosures that contain compounds that are released at a time after electroprocessing, such as at the time of implantation or upon later stimulation or interaction. In one illustrative embodiment, transfection agents such as liposomes contain desired nucleotide sequences to be incorporated into cells that are located in or on the electroprocessed material or matrix. In other embodiments, cell fragments or cell debris are incorporated into the matrix. The presence of cell fragments is known to promote healing in some tissues.

Magnetically or electrically reactive materials are also examples of substances that are optionally included within compositions of the present invention. Examples of magnetically active materials include but are not limited to carbon black or graphite, carbon nanotubes, ferrofluids (colloidal suspensions of magnetic particles), and various dispersions of electrically conducting polymers. Ferrofluids containing particles approximately 10 nm in diameter, polymer-encapsulated magnetic particles about 1-2 microns in diameter, and polymers with a glass transition temperature below room temperature are particularly useful. Examples of electrically active polymers include, but are not limited to, electrically conducting polymers such as polyanilines, polypyrroles and ionically conducting polymers such as sulfonated polyacrylamides are related materials.

In other embodiments, some substances in the electroprocessed material or matrix supplement or augment the function of other substances. For example, when the composition comprises cells that express a specific gene, the composition can contain oligonucleotides that are taken up by the cells and affect gene expression in the cells. Fibronectin is optionally incorporated into the matrix to increase cellular uptake of oligonucleotides by pinocytosis.

As discussed in detail above, the electroprocessed material itself can provide a therapeutic effect. The invention thus includes embodiments involving methods of causing a therapeutic effect through delivery of an electroprocessed material to a location without incorporating additional substances in the electroprocessed material. Embodiments in which the matrix material alone is delivered as well as those in which other substances are included in the matrix are within the scope of the present invention.

Methods of Making the Composition

Electroprocessing

The method of making the compositions includes electroprocessing the materials and optionally electroprocessing the substances. As defined above, one or more electroprocessing techniques, such as electrospin, electrospray, electroaerosol, electrosputter or any combination thereof may be employed to make the electroprocessed materials and matrices in the compositions of the present invention. In the most fundamental sense, the electroprocessing apparatus for electroprocessing material includes a electrodepositing mechanism and a target substrate. The electrodepositing mechanism includes a reservoir or reservoirs to hold the one or more solutions that are to be electroprocessed or electrodeposited. The reservoir or reservoirs have at least one orifice or nozzle to allow the streaming of the solution from the reservoirs. One or a plurality of nozzles may be configured in an electroprocessing apparatus. If there are multiple nozzles, each nozzle is attached to one or more reservoirs containing the same or different solutions. Similarly, there can be a single nozzle that is connected to multiple reservoirs containing the same or different solutions. Multiple nozzles may be connected to a single reservoir. Because different embodiments involve single or multiple nozzles and/or reservoirs, any references herein to one or nozzles or reservoirs should be considered as referring to embodiments involving single nozzles, reservoirs, and related equipment as well as embodiments involving plural nozzles, reservoirs, and related equipment. The size of the nozzles can be varied to provide for increased or decreased flow of solutions out of the nozzles. One or more pumps used in connection with the reservoirs can be used to control the flow of solution streaming from the reservoir through the nozzle or nozzles. The pump can be programmed to increase or decrease the flow at different points during electroprocessing. In this invention pumps are not necessary but provide a useful method to control the rate at which material is delivered to the electric field for processing. Material can be actively delivered to the electric field as a preformed aerosol using devices such as air brushes, thereby increasing the rate of electrodeposition and providing novel combinations of materials. Nozzles may be programmed to deliver material simultaneously or in sequence.

The electroprocessing occurs due to the presence of a charge in either the orifices or the target, while the other is grounded. In some embodiments, the

nozzle or orifice is charged and the target is shown to be grounded. Those of skill in the electroprocessing arts will recognize that the nozzle and solution can be grounded and the target can be electrically charged. The creation of the electrical field and the effect of the electrical field on the electroprocessed materials or substances that will form the electroprocessed composition.

The target substrate can also be used as a variable feature in the electroprocessing of materials used to make the electroprocessed composition. Specifically, the target can be the actual substrate for the materials used to make electroprocessed matrix, or electroprocessed matrix itself is deposited. Alternatively, a substrate can be disposed between the target and the nozzles. For instance, a petri dish can be disposed between a nozzles and a target, and a matrix can be formed in the dish. Other variations include but are not limited to non-stick surfaces between the nozzles and target and placing tissues or surgical fields between the target and nozzles. The target can also be specifically charged or grounded along a preselected pattern so that the solution streamed from the orifice is directed into specific directions. The electric field can be controlled by a microprocessor to create an electroprocessed matrix having a desired geometry. The target and the nozzle or nozzles can be engineered to be movable with respect to each other thereby allowing additional control over the geometry of the electroprocessed matrix to be formed. The entire process can be controlled by a microprocessor that is programmed with specific parameters that will obtain a specific preselected electroprocessed matrix. It is to be understood that any electroprocessing technique may be used, alone or in combination with another electroprocessing technique, to make the compositions of the present invention.

Any material that can be electroprocessed is within the method of the present invention. Forms of electroprocessed collagen include but are not limited to preprocessed collagen in a liquid suspension or solution, gelatin, particulate suspension, or hydrated gel. An example for fibrin is a preformed gel electroprocessed by subjecting it to pressure, for example by using a syringe or airbrush apparatus with a pressure head behind it to extrude the fibrin gel into the electrical field. In general, when producing fibers using electroprocessing techniques, especially electrospinning, it is preferable to use the monomer of the polymer fiber to be formed. In some embodiments it is desirable to use monomers to produce finer filaments. In other embodiments, it is desirable to include partial fibers to add material strength to the matrix and to provide